of his never having received any proper training in the rudiments of science. If the appearance of this article serve to call the attention of the managers of our public schools, and others interested in education, to the painful consequences which may result from the want of a preliminary grounding in the facts of science and the principles of scientific reasoning—then we think it will not have been written in vain.

THE STORM OF FRIDAY, OCTOBER 14

THIS great storm, which appeared so suddenly, sped its course over North-Western Europe so rapidly, and involved so wide a region in its destructive violence, will be long remembered for the well-nigh unparalleled loss of human life which it has occasioned among our fishing population between the Forth and the Tweed. For some days previously atmospheric pressure had been low to the north of the British Isles and high to the south, the difference from north-west to Land's End being about an inch, thus giving steep gradients, and resulting strong west and north-west winds, and stormy seas along the west coast; and as the area of low pressure moved very slowly eastwards the weather conditions continued with some persistence substantially the same. At length on Thursday morning the daily weather charts showed that a change had just begun in the extreme south-west of Ireland, at Valentia, where, and where only, with a barometer beginning to fall, the wind had changed to a southerly direction, but everywhere else in the British Islands it remained north-westerly; whilst at the same time the area of high pressure to the south was advancing from France to Spain, indicating that the path of the coming storm would take a more southerly course. By 2 p.m. the area of a falling barometer had spread eastwards, and the wind changed to south-west as far as Holyhead; and by 6 p.m. observations showed the continued rapid easterly advance of the storm, the wind being now southerly or south-westerly at all the telegraphic stations except Nairn, where it was west-north-west, showing that Nairn was still within the influence of the slow-moving depression to the north.

High winds and very heavy rains occurred during the night over the northern half of Great Britain, and on Friday morning the weather charts showed that North-Western Europe was involved in a storm of great intensity, the centre of which had now advanced as far as Midlothian. Gradients were steep all round the low centre of pressure, and consequently gales and storms of wind prevailed in all parts and in all directions over the British Islands, being west over France and the south of England, south-west and south over the north of England and the North Sea, north-east in the northern half of Scotland, and north-west in Ireland. From the barometric readings published in the *Times* it is seen that the lowest reading occurred in London about 8 a.m., and, in accordance with the isobars on the Weather Chart, the lowest reading occurred in Edinburgh at the same hour. In London, which was some distance from the centre of the storm, the lowest barometer was only 29·086 inches, but in Edinburgh, over which the centre passed, pressure fell to 28·425 inches, which was an inch lower than it was twelve hours before. After 8 a.m. a rapid recovery of pressure set in; the most rapid rise of the barometer in London was 0·214 inch in the two hours from 4 to 6 p.m., and 0·163 inch in the two hours immediately following. In Edinburgh the increase proceeded at a much more rapid rate, beginning with 0·018 inch, from 8 to 9 a.m., and increasing gradually to 0·166 inch from noon to 1 p.m., and 0·150 inch from 1 to 2 p.m., after which it rose less rapidly, and continued to do so at a steady, though greatly diminished, rate for two days till Sunday at 10·30 a.m., when the barometer stood at 30·370 inches, having thus risen nearly two inches in little more than forty-eight hours.

On Saturday morning the centre of the storm had advanced fully 600 miles to eastward, being at the high daily average of 25 miles an hour, and was now near the south-west angle of Lake Wener in Sweden. Here the lowest barometer was about 28·600 inches, whilst at the same time to westward at Valentia pressure had risen to 30·220 inches, thus giving for the southern shores of the North Sea steep gradients for north-west winds, which, with the high seas they raised, proved very destructive to those coasts.

The anticyclone indicated by the high barometer following in the wake of the storm was accompanied with temperatures unusually low for the season during the night of Saturday–Sunday, when temperature fell to 27°·0 at Parsonstown and Nottingham; 29°·0 at Ardrossan; and 32°·0 at Leith, Shields, Cambridge, Oxford, and Mullaghmore. Snowfalls of some depth occurred in many districts, doing no little damage to green crops, and in later districts to grain crops still standing in the fields.

The lamentable destruction to fishing-vessels off the coast of Berwickshire was doubtless to no inconsiderable extent due to the deceptive character of the weather on Friday morning in cases where the barometer either is not consulted, or such a fall as an inch during the twelve hours immediately preceding, is discredited as a precautionary warning. In Midlothian, shortly after eight o'clock, the clouds broke up and the sun shone in a sky rapidly clearing of clouds. Soon, however, a change commenced, and within an hour, behind a low bank of darkish-looking clouds in the northern horizon, a long bank of ashy, leaden-hued, ominous clouds began to appear, and rose higher in the sky. In a brief space of time the whole of the sky was overcast, and a darkness quickly followed so great as to render gas necessary in reading the morning newspaper. It was remarked at the time that the darkness lasted three or four times longer than is usually the case with the darkness which is observed immediately to be followed by a complete change of wind. When it passed away, the wind had changed from south-west to north-north-east and the temperature fallen, and thereafter the wind gradually rose to a gale. On the other hand, off the Berwickshire coast the darkness was denser and more threatening, and almost simultaneously with its approach a hurricane broke out with a devouring energy which bore everything before it, and, explosively as it were, instantly rose to a height which, judging from actual facts related by the fishermen who escaped and the spectators on the shore, can perhaps only be paralleled in this country in recent years by the Edinburgh hurricane of January 24, 1868. On land many lives were lost in London and elsewhere, and in all parts of the country chimney-stacks, roofs, and walls were blown down, telegraph lines were wrecked, and tens of thousands of the finest trees were snapped asunder and levelled with the ground. When there has been time to collect the records of this storm, it will be found to have been one of the most destructive to life and property in these islands in the memory of the present generation.

THE INTERNATIONAL EXHIBITION AND CONGRESS OF ELECTRICITY AT PARIS[1]

IV.

AS we believe our readers will be interested in a fuller description of the arrangements for the telephonic hearing of the Opera than we have yet given, we extract the following from Nos. 50 and 51 of the new and popular French electrical journal, *La Lumière Électrique*, edited by Count Du Moncel. It is from the pen of the Count himself, and is, we believe, the best account yet published. Our own additions are in square brackets.

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[1] Continued from p. 564

One of the greatest successes of the Exhibition of Electricity is certainly the arrangement for the telephonic hearing of theatrical performances which has been organised by the Société Générale des Téléphones. By means of an electrical connection which has been established between the Opera, the Théâtre Français, and the Exhibition Palace, it has become possible to hear in the most complete manner the pieces played on our two principal dramatic stages. The singing of the Opera especially has a fairy-like effect, and all who have been so fortunate as to penetrate into the sanctuaries reserved for these hearings go away astonished and enchanted as if they had come from a dream of the Thousand and One Nights. The effect is in fact captivating; for the singing of the Opera is positively better heard in this way than in the Opera House itself; the words are more distinct, and the delicate turns of sound are better rendered, in consequence doubtless of the fact that the telephonic transmitters, being interposed between the actors and the orchestra, the instrumental music is to some extent sacrificed to the singing. It would scarcely be an exaggeration to say that we hear too well, for the words of the prompter are heard with a distinctness which is somewhat distracting. In short the success is complete, and the Société des Téléphones, as well as M. Ader, who has superintended the arrangements, have a large claim on public gratitude.

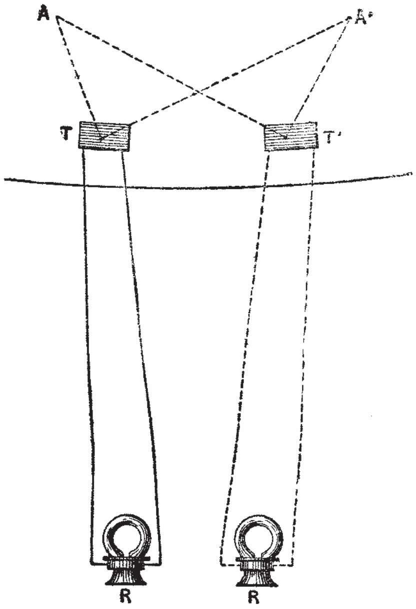

FIG. 1.—Stereoscopic combination of two transmitters.

The theatrical performances are to be heard not only in the four rooms allotted to the public, but also in a little boudoir off the so-called Salon de l'Impératrice, which is at some distance from the others. Here there are no external noises to distract, and it is possible to enjoy the charming melodies at one's ease.

The four public rooms, one of which is represented in Fig. 3, are covered on all sides with drapery to deaden external sounds, and the telephones are hung in pairs from wooden panels, of which there are twenty in each room. Chandeliers supporting lamps of Swan, Maxim, and Lane-Fox light each of these rooms, and the entrance to each is through a kind of pen which holds twenty persons in single file. The auditor has only to put the two telephones to his ears to hear the theatrical performance. On the table in the centre of the room there is a telephone for the use of the officials.

The connecting wires pass across the northern portion of the galleries of the Exhibition, and thence through sewer pipes to the Opera House and Théâtre Français, where they abut on the stage of each of these theatres, and terminate in transmitters, which are in fact microphones with multiple contacts. Those which are employed are of the Ader system, and are the same as those which are used for the Telephonic Exchange of Paris, but with one slight modification to meet the exigencies of this special purpose. As is well known, the acting portion in these transmitters consists of a sort of gridiron composed of two fixed parallel bars of carbon loosely connected by means of six smaller cross-bars of the same material, whose ends are supported by resting in holes in the sides of the large bars, and are free to rattle about in them. This frame of carbons is attached in a horizontal position to the under side of a thin board of pine, which is the vibrating plate. [Sometimes the gridiron is doubled, so as to consist of three fixed bars, the middle one being connected to each of the others by five small bars (ten small bars in all). The terminals of the battery are in both cases connected with the two outside bars, and the current divides itself between the five small bars as it passes from each large bar to the next. An ordinary five-barred gate, without the sloping tie, gives a good idea of the general form. It is one of the many forms which have been given to Crossley's microphonic transmitter, and is believed to be about on a par with many other forms.]

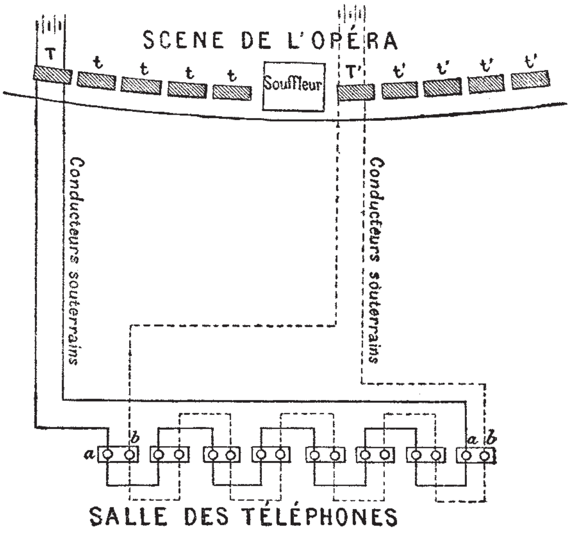

FIG. 2.—Connections between Opera and hearing-room.

On account of the multiplicity and variety of sounds which it is capable of transmitting, it has been fixed on a leaden socket standing on four india-rubber feet, to deaden the effect of the vibrations of the floor of the stage. The necessity for such an arrangement is obvious in a theatre where the floor is continually being shaken by dancing.

At the Opera House there are ten transmitters of this kind disposed on both sides of the prompter's box along the edge of the stage. The arrangements suitable for any theatre vary according to the position and magnitude of its stage; and M. Ader informs us that he intends to double the number of transmitters at the Opera House, so as to render the sounds still more intense.

The receivers in the telephonic rooms of the Exhibition are the *téléphones à surexcitation* of M. Ader, which we have described more than once in this journal, and the arrangement of the batteries which work these multiple systems possesses no special feature. The batteries are placed wherever there is room for them, generally underneath the stage; but as they would become too highly polarised if left in circuit during a whole representation, it is necessary to renew them every quarter of an hour, and for that purpose a commutator has been provided which allows the change to be made in a moment. This comutator consists of a board furnished with as many spring-plates as there are transmitters, and serves to keep up the connection between the transmitters and the batteries.

The greatest difficulty that has been met with has been how to render the transmitter more sensitive to the voices of singers than to the loud sounds emitted from the instruments of the orchestra, which would otherwise predominate. M. Ader has had to make a number of acoustic studies and trials on this point, which we cannot explain without going too much into detail, and has completely vanquished the difficulty; we will, however, explain the means which M. Ader has employed to enable the auditor to follow to some extent the movements of the actors on the stage.

Everybody knows the stereoscope, which enables a person, by means of the superposed visual impressions of the two eyes, to see the stereoscopic images with their natural relief. M. Ader applies the same principle to the perception of sounds.

Suppose two microphonic transmitters, placed on the stage at T and T′ (Fig. 1). Let one of them be connected by wires with the receiver R, and the other with the receiver R′, these receivers being applied to the two ears of the auditor, and suppose an actor to stand first at A and then at A′. In the former position, as he is nearer to the transmitter T than to T′, his singing will be heard loudest with the left ear; but when he is at A′ he is nearer to T′ than to T, and the right ear will receive the strongest impression. Thus as he goes from A to A′ the definite sensation which the auditor will receive will be that of a diminution of loudness in the left and an increase of loudness in the right ear, which is the same as the sensation which we experience when a person who is speaking walks from our left to our right. The same principle will apply to a number of actors crossing one another on the stage. Fig. 2 explains how this idea has been carried out at the Opera House.

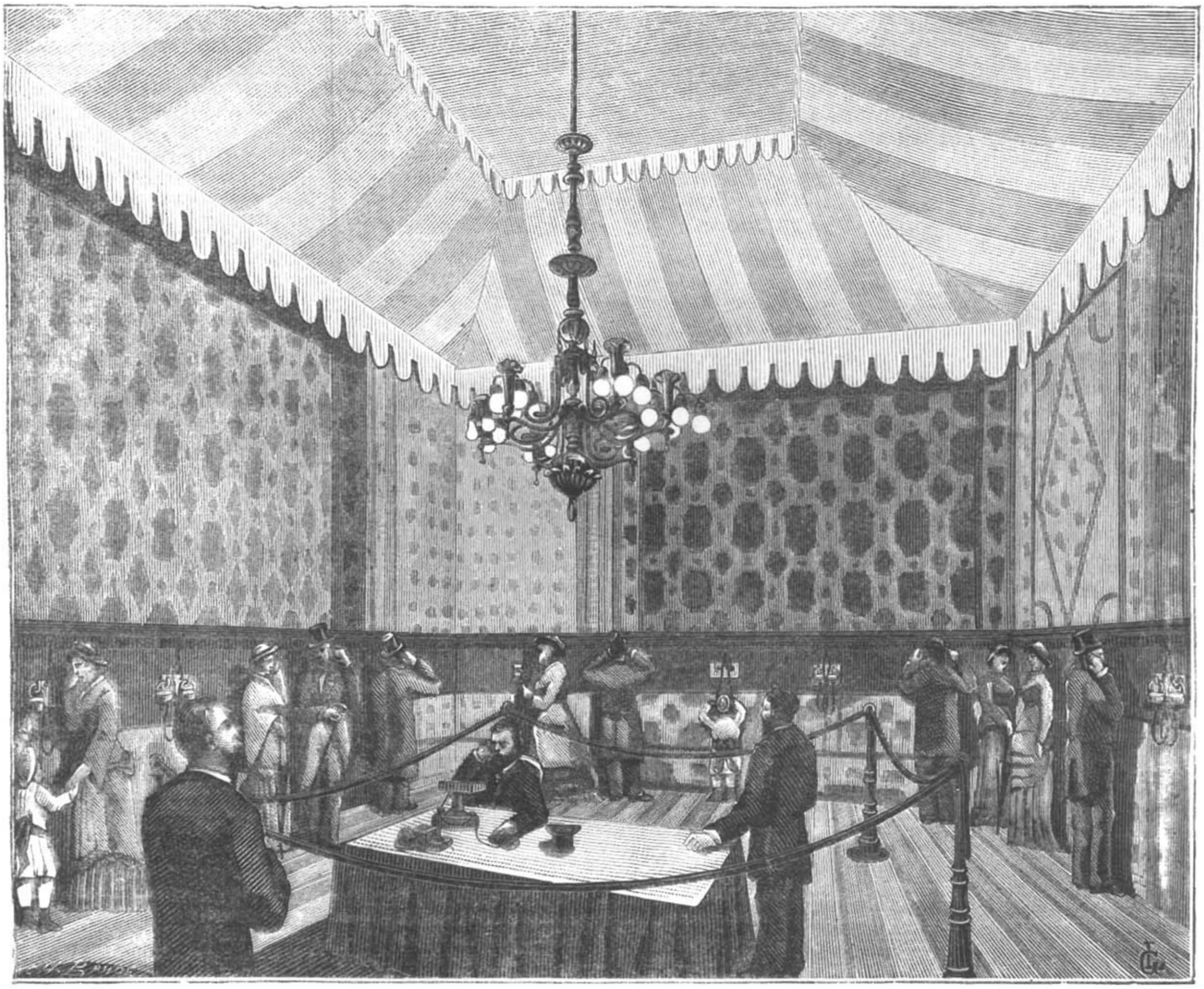

FIG. 3.—One of the hearing-rooms in the Exhibition.

We have already stated that there are five transmitters on each side of the prompter's box [marked *souffleur* in the figure] along the edge of the stage. Each of these transmitters has its own separate circuit, and consequently its own separate underground cable. On arriving at the hearing room, the cables terminate each in eight receivers, but always in such a manner that to each auditor the effects are very different for his two ears. Fig. 2 shows the course of the circuits for two transmitters, and the circuits for the others are arranged on the same plan. A little study of this figure is enough to show that in each pair of telephones in the receiving room the left one corresponds to the transmitters on the left side of the stage, and the right one to the transmitters on the right side. All the left-hand telephones are in one circuit, and all the right-hand ones in the other. This arrangement, which is clearly shown in the figure, is very ingenious, and though a simpler arrangement with a smaller number of circuits could have been employed, the additional expense involved in having so many circuits was not allowed to stand in the way, as it was necessary in order to make forty-two pairs of telephones work properly; and even this number is not sufficient to satisfy the public curiosity.

These brilliant experiments show that there was no exaggeration in the statements which were published soon after the invention of the telephone, to the effect that concerts and sermons had been heard at great distances. It cannot now be said that we were too credulous when we announced in 1878 that the opera "Don Pasquale" had been very well heard in the telephone at Bellinzona, and that none of the fine turns of this charming music had been lost. We believe indeed that the results then obtained were far inferior to those which we have now the opportunity of enjoying; and still more marvellous results in telephony have, we are informed, been quite recently obtained.

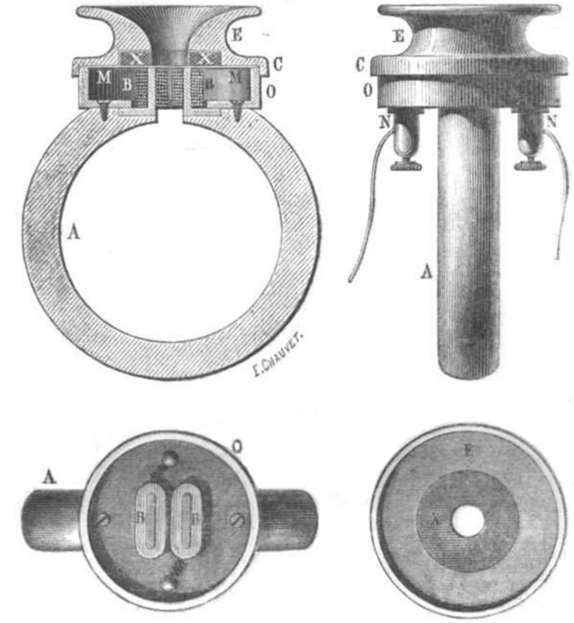

FIG. 4.—Ader's telephone *à surexcitation.*

Fig. 3 represents one of the hearing rooms, namely, that which is lighted with Lane-Fox lamps. A mahogany wainscotting is carried round the walls at about the height of the ear, and on it are fixed twenty small wooden panels furnished with hooks to hang the telephones on. The telephones are connected with the underground conductors by means of flexible wire cords which come out of the wainscotting, so that nothing is easier than for the auditors to put the telephones to their ears. As the telephones are connected, eight in each series, with one and the same pair of microphonic transmitters, and the different pairs of transmitters occupy different positions on the stage, the effects are not the same for all the telephones. Those which are in connection with transmitters at the extreme right or left are more affected by the sounds of the loud instruments in the orchestra than those which are connected with the transmitters nearest the prompter; but these latter, on the other hand, are more affected by the prompter's voice.

To make the effects as equal as possible, M. Ader has so arranged the connections that the two transmitters which form one pair are in precisely opposite conditions; for instance, the transmitter at the extreme left is paired with the first to the right hand of the prompter, the second from the extreme left with the second to the right of the prompter, and so on. The best effect is obtained from the pair which occupy the middle places in the two sets. These differences give an obvious explanation of the different accounts given by different persons of the predominating sounds which they have heard, and explain why many of them, having heard in different parts of the same room, have not received the same impressions. Naturally enough they attribute the difference to the quality of the telephones, but though it is possible that some of these may be better than others, it is to the positions of the transmitters on the stage that the differences are chiefly attributable.

[The receiving instrument, which, as above stated, is the *telephone à surexcitation* of M. Ader (pronounced like the English name Adair), is very similar to the Gower-Bell receiver, having like it a steel horseshoe magnet, which forms nearly a complete ring, and which, being coated with nickel, serves as the handle. Round the two soft iron pole-pieces of this magnet coils of very fine wire are wound, which are in circuit with the line wires, so that the currents from the transmitter at the sending-station pass through them. A thin circular plate of iron, fastened by its edges, is fixed at a very small distance from the pole-pieces, and serves as the vibrating diaphragm. The peculiarity of the Ader telephone is that a flat ring of soft iron is fixed at a little distance behind this vibrating plate; that is to say, on the side remote from the magnet, its office being to concentrate and intensify the force of the magnet upon the diaphragm. This is what is meant by *surexcitation.* The plate, in fact, is more strongly attracted by the magnet than it would be if this ring were absent. In Fig. 4 (which consists of three sections and one elevation of this telephone) A is the steel magnet, B B are the coils, M M is the vibrating diaphragm, X X the flat ring for intensifying the force of the magnet upon the diaphragm, O the resonance chamber, and E the trumpet-shaped opening which is applied to the ear.]

The following account of Rysselberghe's meteorograph was accidentally omitted from a previous article:—

One of the neatest specimens of electrical mechanism is the meteorograph of M. Van Rysselberghe, exhibited by the Royal Observatory of Brussels. It gives its records not only at the place of observation, but at one or more distant stations, and is now giving every night at Paris a record of the indications of the instruments at Brussels. Once every ten minutes it comes into action and registers one after the other the six following elements:—(1) temperature; (2) humidity; (3) water in rain-gauge: (4) direction of wind; (5) barometer; (6) velocity of wind. It also makes a mark about every half second due to the action of clockwork at the sending-station.

The registration is made by a diamond point on a thin plate of zinc which is bent round the surface of a revolving cylinder, and which is covered with lamp-black to make the marks more visible. This plate serves afterwards for printing any number of copies. There may be several of these cylinders at as many different stations, all receiving simultaneously the indications furnished by any one station. The mode of action is as follows:—

Let us take for example the case of one of the thermometers. The thermometer-tube is vertical and open at the top. A long metallic probe smaller than the tube of the thermometer descends once in ten minutes with a slow motion produced by clockwork. The probe, by touching the mercury, completes a circuit, through which a current is instantly transmitted from a local battery. The line-wire is included in this circuit, and a corresponding movement is produced in the diamond point of the receiving instrument. A local electro-magnet is also made by this current, and the arrangements are such that the current is thus diverted from the mercury at the instant after the probe has touched it, and there is consequently no spark when the probe leaves the mercury. The instantaneous current which thus passes is always from the probe to the mercury; in other words the mercury is the negative and the probe the positive terminal. If any moisture be present its oxygen goes to the probe (which is of platinum) and the hydrogen to the mercury, which thus, instead of oxidising, is kept always bright. Evidently the higher the mercury stands in the tube, the sooner will the contact be made, and thus the scale of equal parts before-mentioned gives the height of the mercury.

The diamond point makes a succession of short marks which (in virtue of a mechanical interruption) form a regular series up to the moment when the probe touches the mercury, after which they cease for several seconds. The cylinder revolves once in ten minutes, and the diamond point has at the same time a slow longitudinal motion (being mounted on a screw axle), so that the successive indications of the same thermometer form a nearly continuous curve (traced by points).

Thus by one line wire and one diamond point the curves for all the six instruments are drawn at a station which may be 200 or 300 miles distant. The value of such an instrument for furnishing the director of a central station with accurate data on which to base his weather-predictions speaks for itself; and as regards expense, all the expenses of photography and of reducing and engraving photographic traces are saved. It has been worked in Belgium over a wire of the length of 750 miles.

(*To be continued.*)

NOTES

THE Royal Institution Session will commence with a course of six lectures on astronomy, adapted to a juvenile audience, by Prof. R. S. Ball, F.R.S., Astronomer-Royal in Ireland. Dr. W. Huggins will give a discourse on Comets at the first Friday evening meeting, January 20, 1882.

THE International Commission for the next transit of Venus, established in Paris under the presidency of M. Dumas, has accomplished its work and published a series of instructions, which will appear in the next number of the *Comptes rendus* of the Academy of Sciences, and be sent to all astronomers and observatories. A complete scheme for international co-operation has been adopted.

As No. 12 of the Bibliographical Contributions, edited by Mr. Justin Winsor of the Harvard University Library, we have a List of the Publications of Harvard University and its Officers, 1870–80. It contains, for example, the publications of the Astronomical Observatory, the Bussey Institution, the Museum of Comparative Zoology, &c., followed by an alphabetical list of the officers (professors, &c.) of the University with their publications, and including such names as those of Agassiz, father and son, J. A. Allen, the ornithologist, J. P. Cooke, professor of chemistry, Asa Gray, H. A. Hagen, professor of entomology, E. C. Pickering, professor of astronomy, the late Benjamin Peirce, S. H. Scudder, N. S. Shaler, J. Trowbridge, professor of physics, and others.

THE experiments made at the Paris Opera in electric lighting have been successful for regulators. Not less than thirty-six Brush lamps illuminated the celebrated monumental staircase, with Werdermann in the circular gallery, and Jaspar in the buffet. Sixty-four Jablockhoff lights were disposed on the ceiling round the chandelier with success in spite of the numerous changes of colour. The incandescent light exhibitors—Swan, Maxim, and Edison—were not ready to act their part, and the opportunity was lost for them; a second will be given to-day.

A RUMOUR has been spread by the *Journal Officiel* that the Electrical Exhibition will be closed on the 1st of November. The impending resignation of M. Cochéry is stated to be at the bottom of this semi-official attempt. But it is certain no alteration will be made in the original date of closing, except to extend the time granted up to December 1.

THE death is announced, at the age of eighty-four years, of M. Dubrunfaut, a well-known French industrial chemist.

IT is stated that M. Herve-Mangon, director of the Paris Conservatoire des Arts et Métiers, has decided to resign his post in order to devote himself more entirely to politics, he having been elected recently as *deputé* for the department of La Manche. Probably he will be succeeded by Col. Laussedat of the Polytechnic School.

PROF. HAECKEL has arrived at Vienna on his way to Ceylon.

IN connection with the Museum and Library, Queen's Road, Bristol, the following syllabus of a course of nine lectures, on literary and scientific subjects, to be delivered during the winter, 1881–82, has been issued:—October 31, 1881, Clements R. Markham, C.B., F.R.S., Sec. R.G.S., the Basque Provinces of Spain; November 14, Prof. W. J. Solas, M.A., F.R.S.E., F.G.S., the Natural History of Volcanoes; November 28, Prof. S. P. Thompson, B.A., D.Sc., F.R.A.S., Electric Storage and Lighting; December 12, Prof. William Ramsay, Ph.D., F.C.S., Improvements in Iron and Steel Manufacture; January 23, 1882, Prof. Bentley, F.L.S., Epiphytic and Parasitic Plants, with some observations on the Life of other Plants; February 6, Ven. Archdeacon Norris, B.D., Canon of Bristol, Redcliffe Church: its Architecture and History; February 20, J. E. H. Gordon, B.A., the Leyden Jar; March 6, W. Saville Kent, Infusoria; March 20, Rev. A. H. Sayce, M.A., the Land of the Phœnicians.

LIEUT. FRIEDRICH WILL will shortly undertake a thorough zoological-entomological investigation of the provinces of Bahia, Pernambuco, and Piauhy; he is sent by the Entomological Society of Stettin, the president of which is Dr. C. A. Dohrn.

WE have received parts 1 and 2 of the first volume of the *Transactions* of the Seismological Society of Japan, containing an address on Seismic Science by Prof. Milne, together with papers by Messrs. Ewing, Wagner, and Gray, on various seismometric and seismographic instruments, and by Mr. Mendenhall on a determination of the Acceleration of Gravity at Tokio. The Society is to be congratulated on the numerous proofs of activity which it has already shown, and on the very valuable scientific work it is doing in this rather neglected branch of study.

A USEFUL paper by Mr. W. J. Harrison, Science Demonstrator for the Birmingham School Board, on the Teaching of Science in Public Elementary Schools, has been issued by him in a separate form. He resumes all the reasons for science-teaching in schools in a clear and forcible manner, and gives some hints that might be of service to science teachers. In Birmingham, we believe, they are now endeavouring to obtain money for science scholarships, by which boys of merit will pass from the Board Schools to the great Foundation School there (King Edward's Grammar School), then to the Mason College,